

# DERIVATION OF THE WATER QUALITY BASED EFFLUENT LIMITATION (WQBEL) FOR PHOSPHORUS IN DISCHARGES TO THE EVERGLADES PROTECTION AREA

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# Water Quality Standards

- ◆ Classifications (Designated Uses)
- ◆ Narrative & Numeric Criteria\*
- ◆ Antidegradation Provision
- ◆ Moderating Provisions

\*derived to protect Designated Use

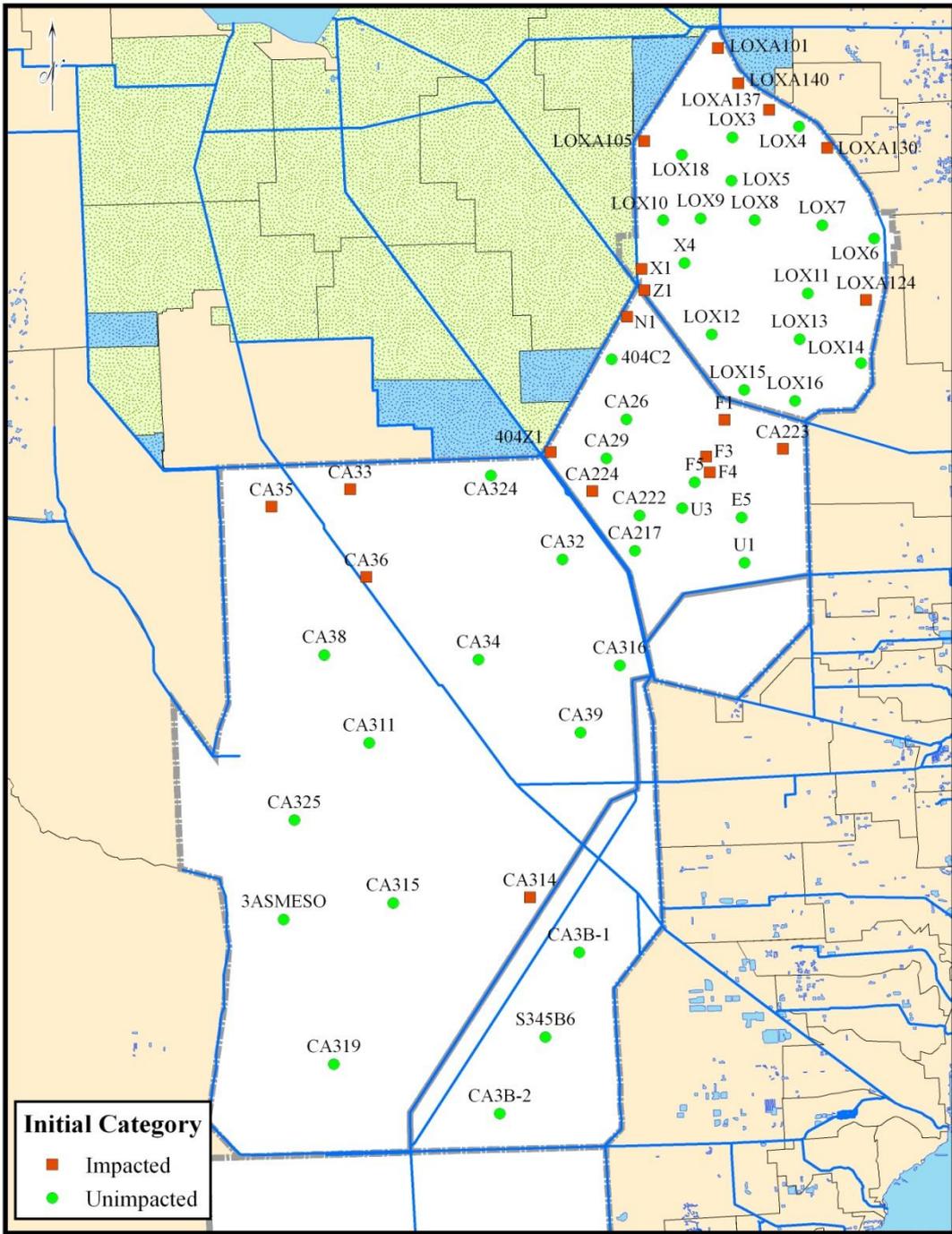
Everglades P criterion -part of the State's water quality standards - specifically derived to protect the Everglades against adverse effects from P enrichment.

# Discharge Limits

- ◆ Associated with permits (federal & state)
- ◆ Derived to achieve criteria
- ◆ Normally expressed as Water Quality Based Effluent Limits (WQBELs) -derived in accordance with Chapter 62-650, Florida Administrative Code.

# What's the difference?

- ◆ In some cases discharge limit & criterion are one in the same (where no translation is necessary to derive the discharge limit from the criterion).
  - ◆ Example – toxicant where 10 µg/L is toxic level
- ◆ That is not the case with the 10 ppb Everglades phosphorus criterion.

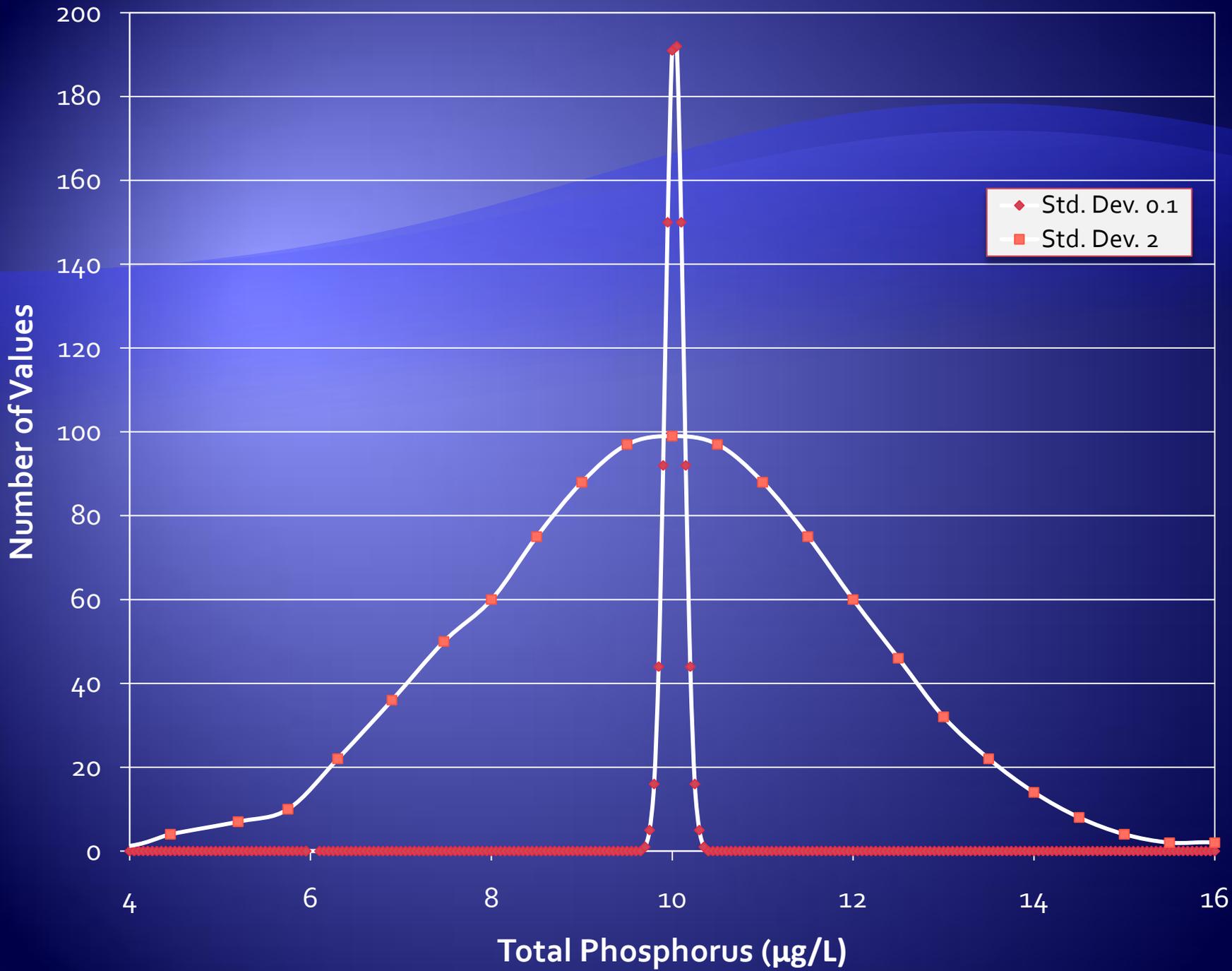


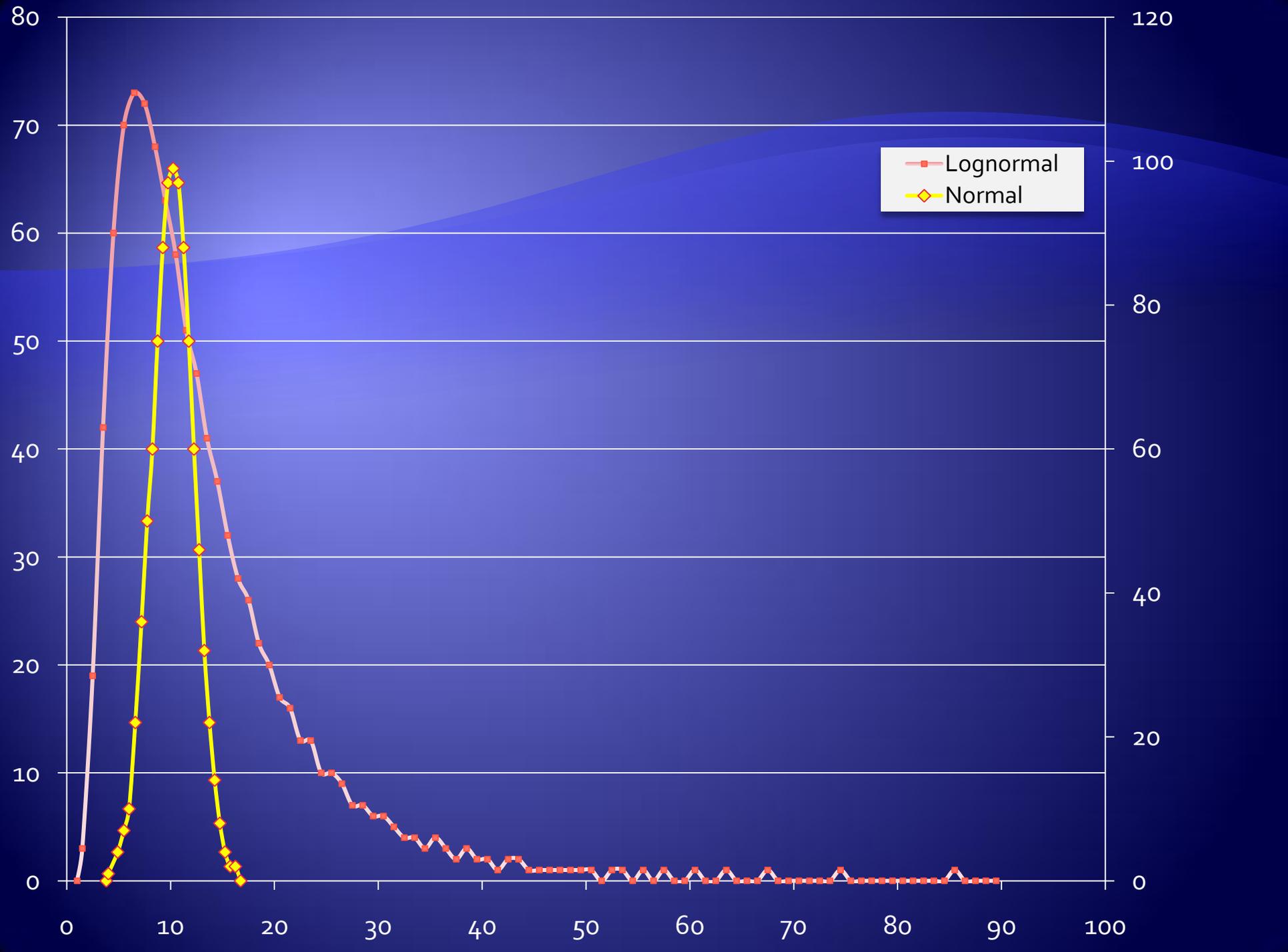
# Everglades P Criterion

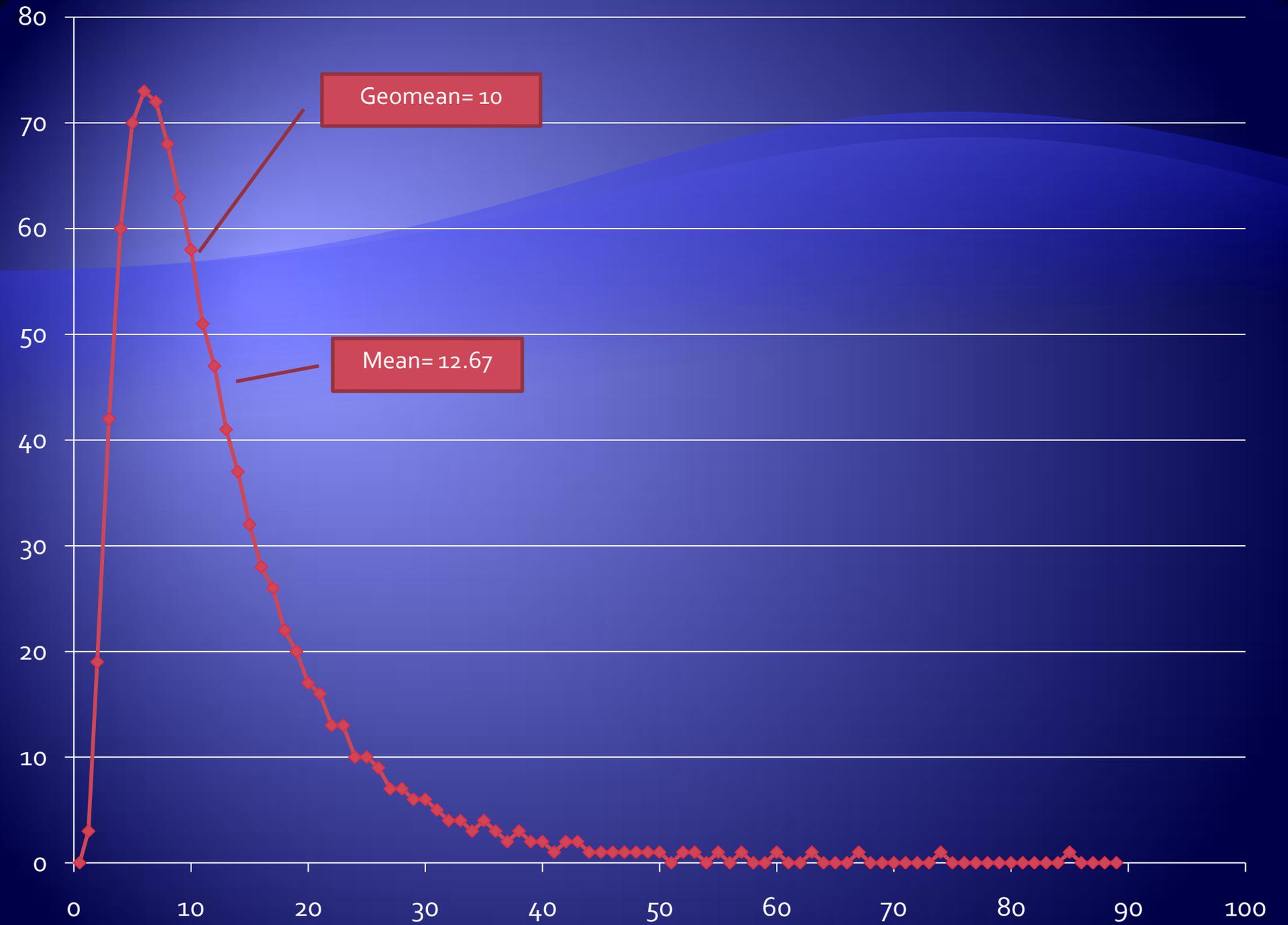
- ◆ Derived & expressed in rule as **Long-Term Geometric Mean**
- ◆ Rule sets forth how tested on short-term basis
  - ◆ 5-year network GM  $\leq 10$  ppb
  - ◆ 1-year network GM  $\leq 10$  ppb 3 out of 5 years
  - ◆ 1-year network GM  $\leq 11$  ppb
  - ◆ Single station AGM  $\leq 15$  ppb
- ◆ Report results annually in SFER

# Discharge Limits

- ◆ Discharge limits normally expressed as discrete term limits (typically monthly or annually)
- ◆ State's STA permits use Annual Limit
- ◆ Discharge limit not normally expressed as GM of concentrations – more typical as Flow-Weighted Mean
- ◆ FWM more accurately represents effect of variability in flow on concentration of P in discharge
- ◆ Weighting high flows makes sense since high concentrations @ high flows have greater potential to cause impacts







# FWM Equation

$$\text{FWM} = \frac{Q_1 C_1 + Q_2 C_2 + Q_3 C_3 \dots Q_n C_n}{Q_1 + Q_2 + Q_3 \dots Q_n}$$

Q = Flow

C = Concentration

# Analogy for FWM Calculation



# WQBEL Development

- ◆ Used statistical properties of STA discharge data based on actual historical monitoring data
  - ◆ Available Data:
    - ◆ ENR – Water Years\* 1995-2000
    - ◆ STA-1E – WY 2007-2009
    - ◆ STA-1W – WY 2001-2009
    - ◆ STA-2 – WY – WY 2002-2009
    - ◆ STA-3/4 – WY 2005-2009
    - ◆ STA-5 – WY 2001-2009
    - ◆ STA-6 – WY 1999-2009
- \*Water Year = May - April of following year

# Method

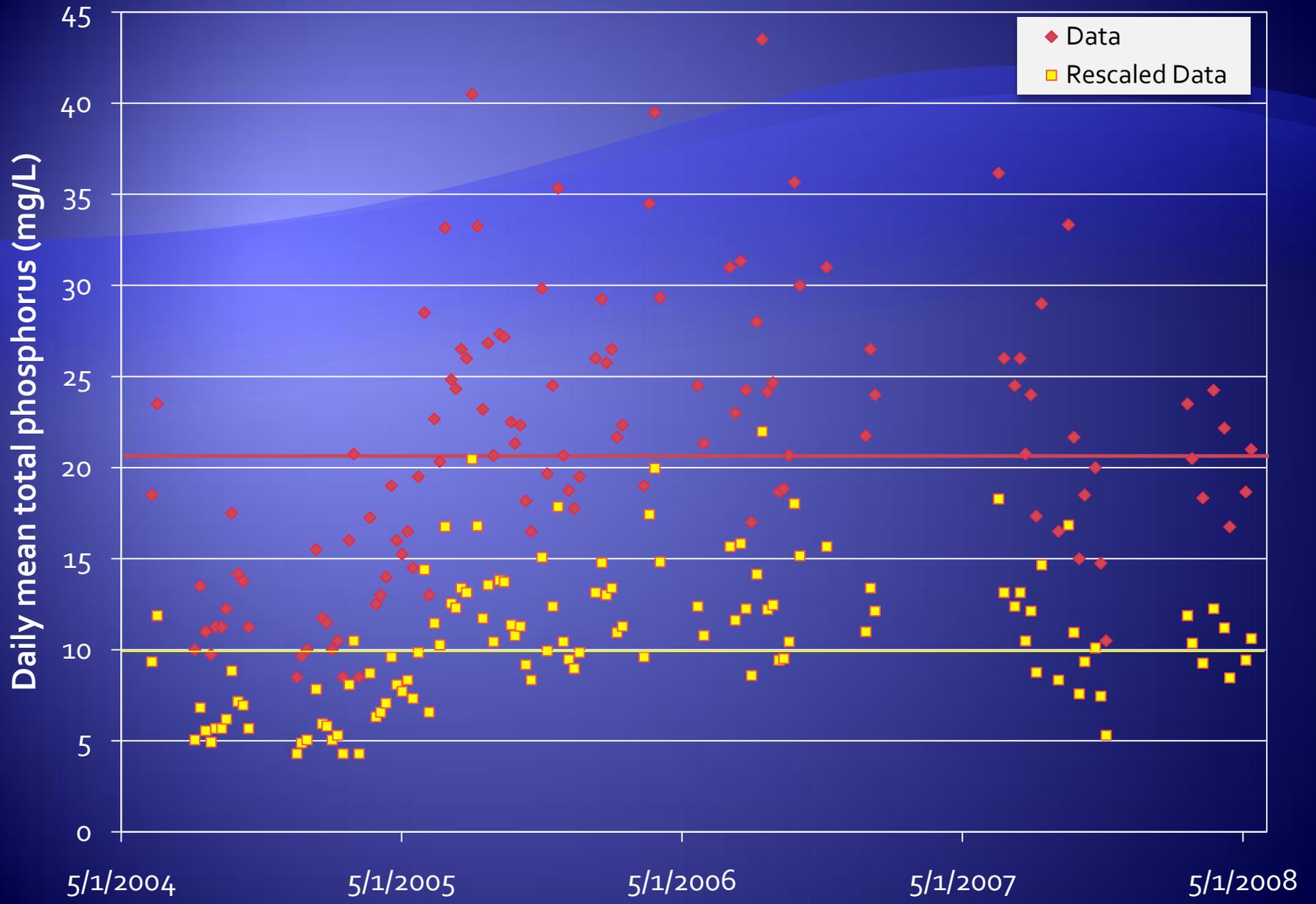
- ◆ Since not achieving 10 ppb GM yet, cannot be used directly - data must be rescaled to 10 ppb
- ◆ Concept is same as used for Interim Effluent Limits (although different data sets used)

## STEPS

1. Rescale Data to long-term GM of 10 ppb
2. Calculate Annual FWM from rescaled data & measured flows
3. Calculate upper limit

# Rescaling Factors

- ◆ Calculated by 2 methods:
  - ◆ 1<sup>st</sup> – GM calculated over entire POR for each STA – rescaling determined as ratio of 10 ppb criterion divided by POR GM (Factors ranged from 0.55 to 0.1)
  - ◆ 2<sup>nd</sup> – calculated as ratio of 10 ppb criterion divided by arithmetic average of AGM (Factors ranged from 0.52 to 0.098)
  - ◆ Both rescaling factors applied to individual STA TP measurements

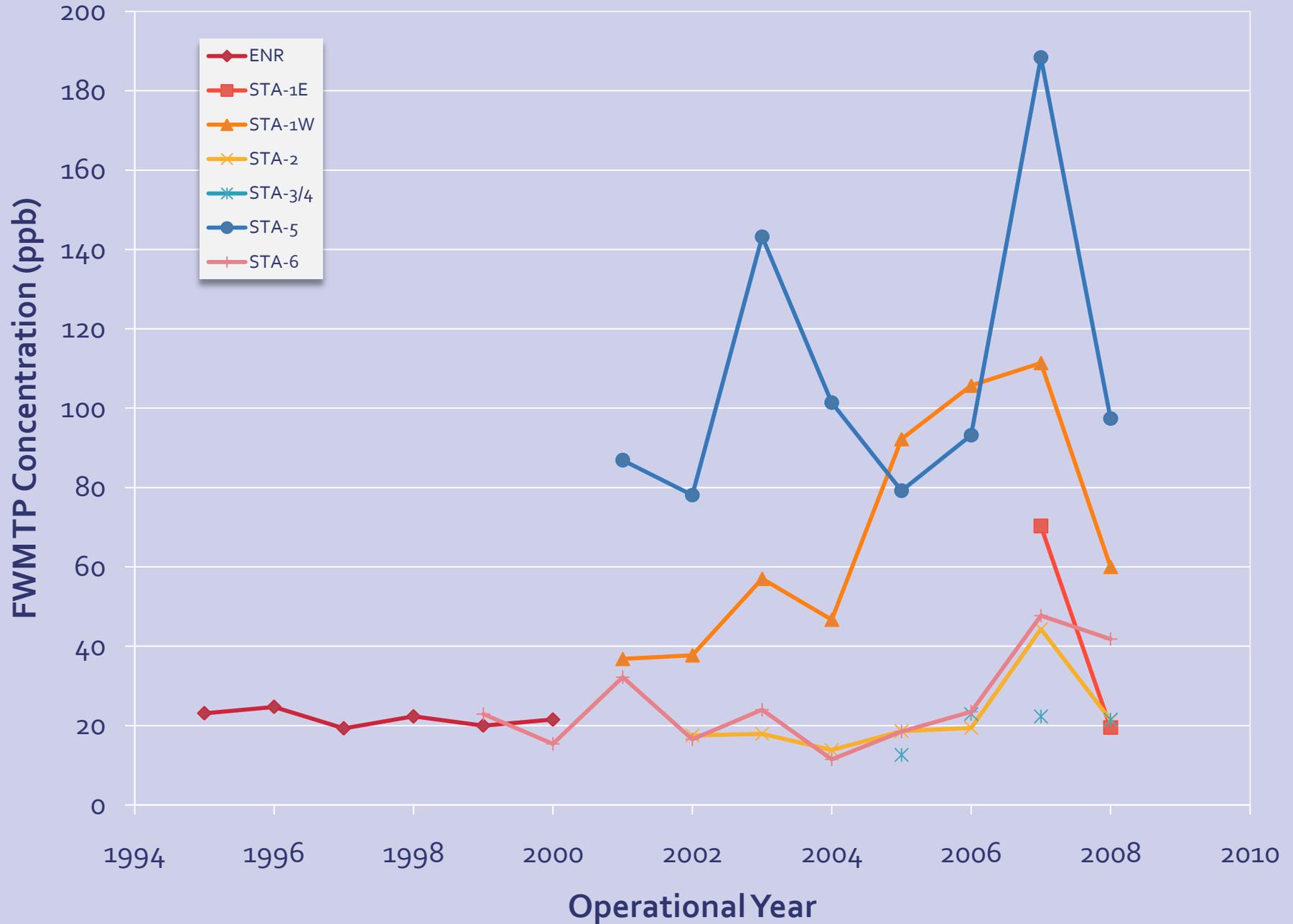


# Derivation of AFWM from AGM

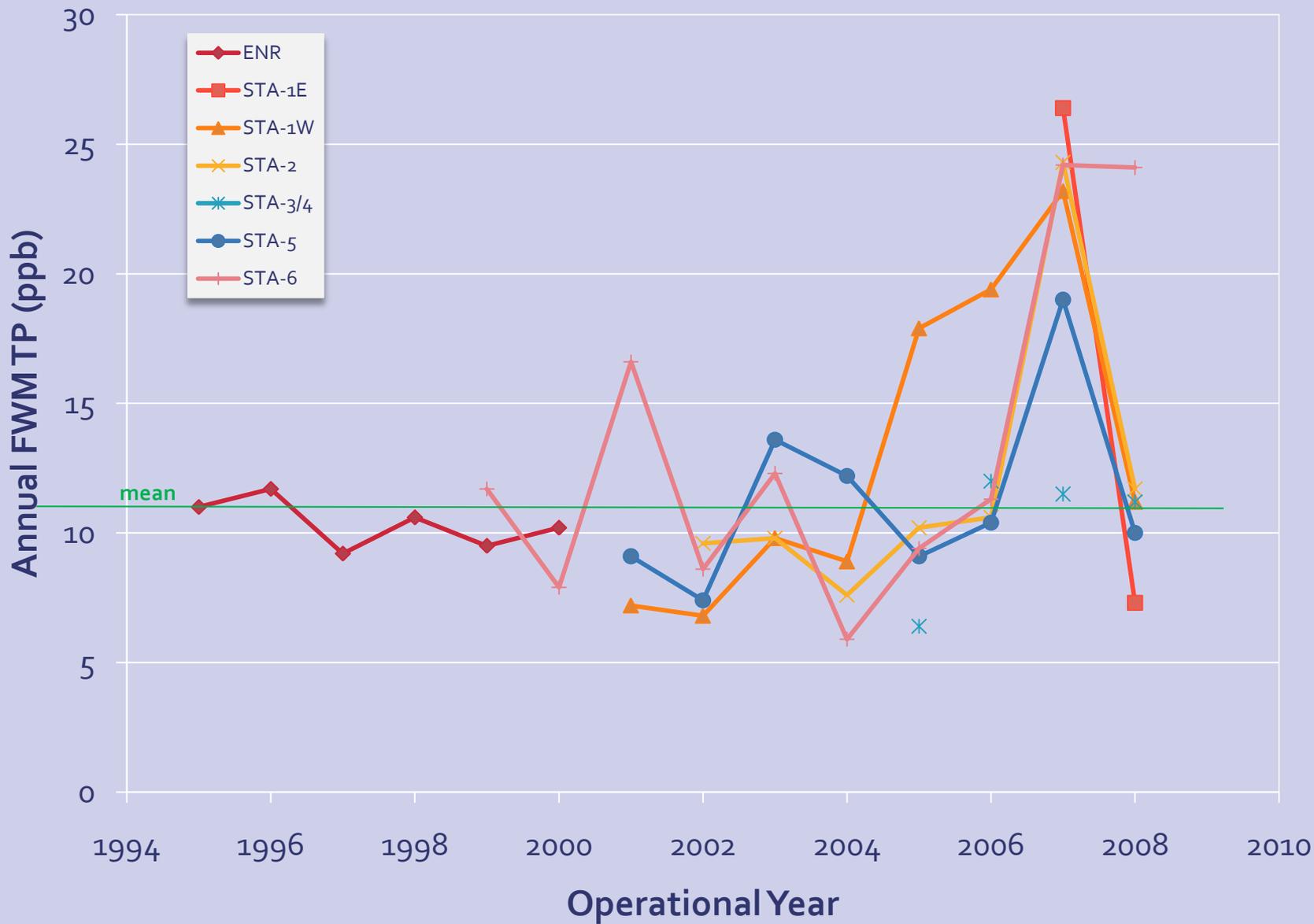
- ◆ Annual FWM calculated from rescaled TP measurements & actual flow data for STA
- ◆ Annual FWMs pooled & used to evaluate relationship between long-term GM of 10 ppb & annual FWMs\*

*\*limited data for many of STAs – necessitates pooling of data to obtain rigorous estimate of discharge under variety of conditions*

# Original Annual FW Mean TP Concentrations



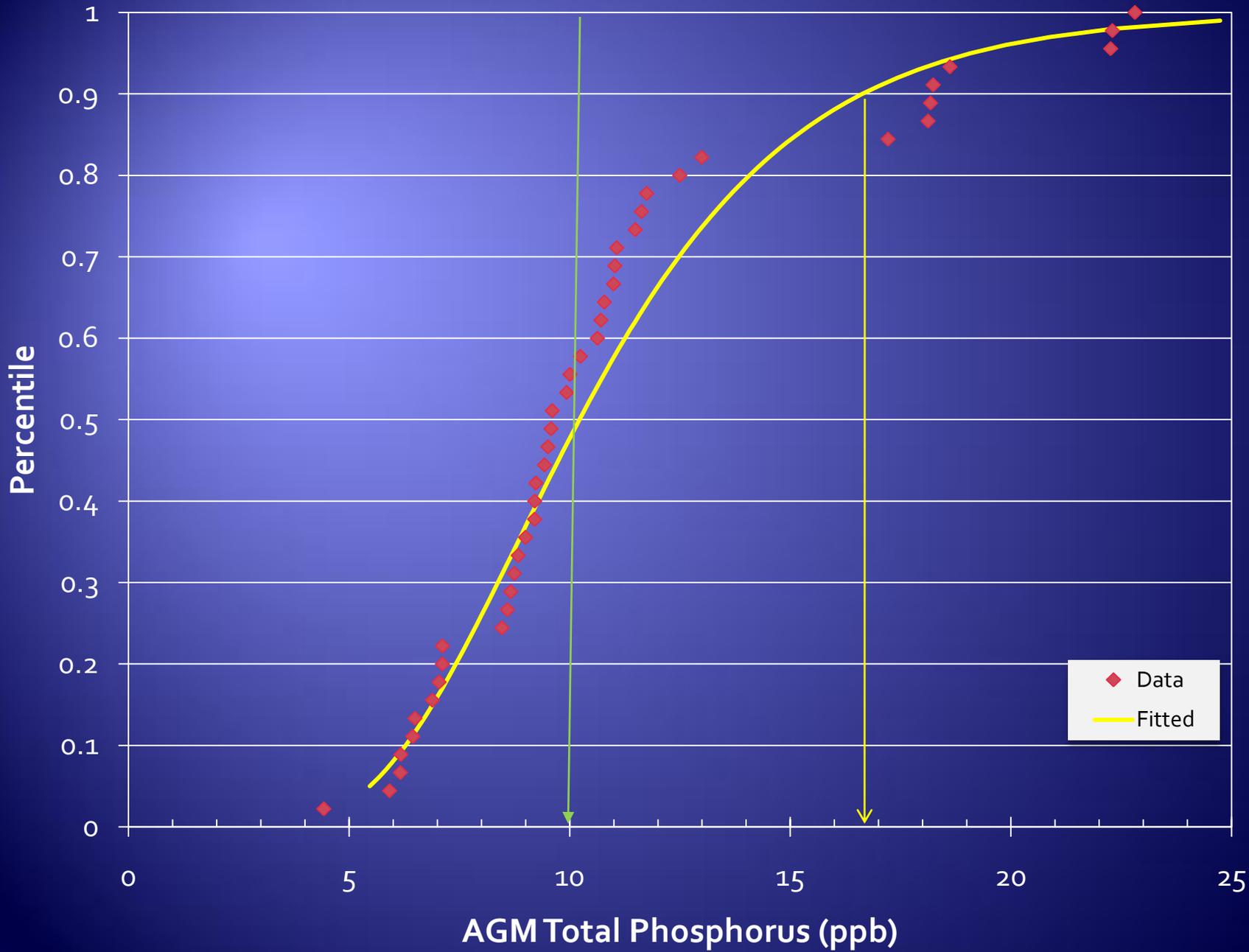
# Rescaled Annual FW Mean TP Concentrations



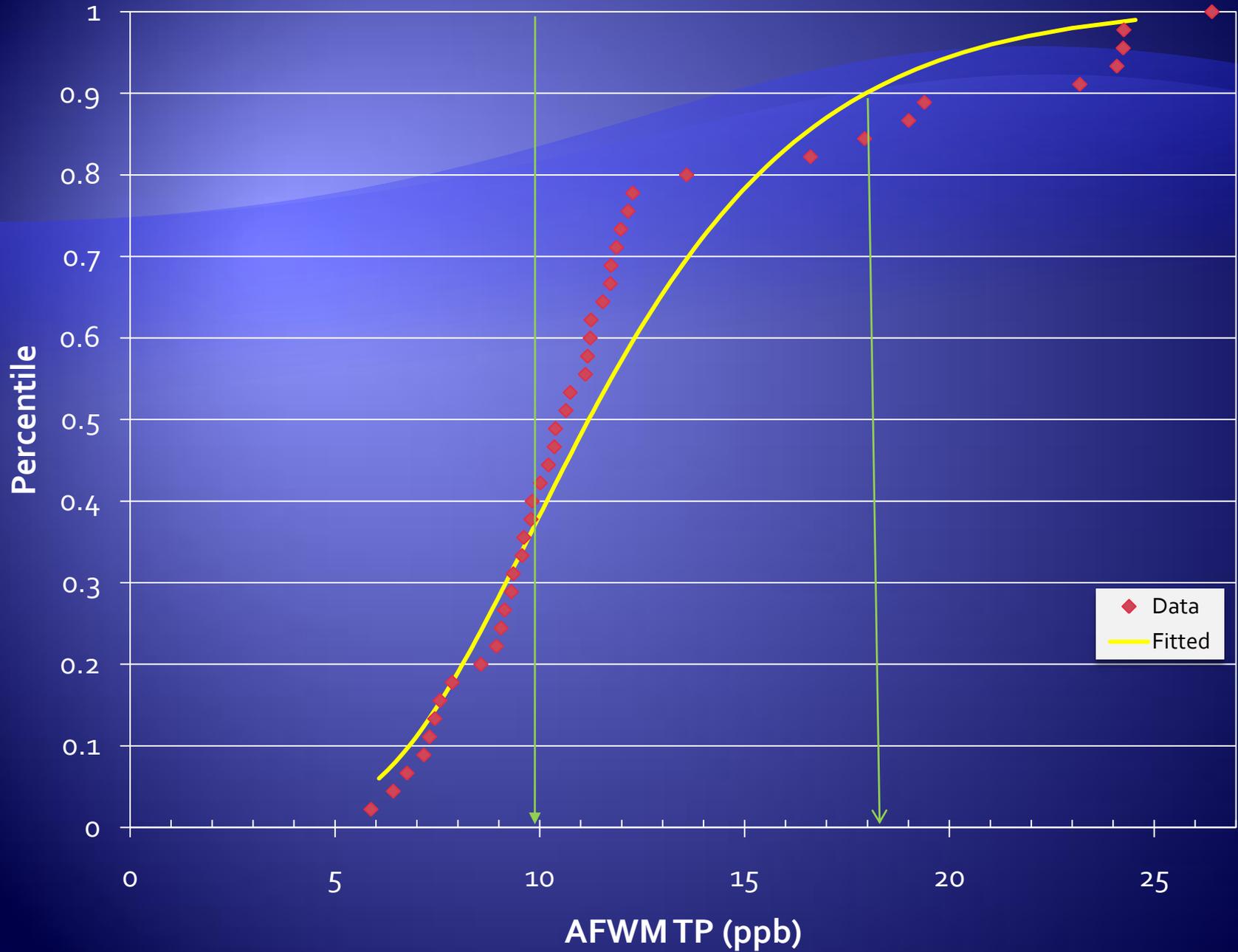
# Maximum Annual Limit Calculation

- ◆ WQBEL estimates were derived by fitting lognormal frequency distributions to the rescaled annual flow-weighted mean (FWM) concentration data for the pooled STA data set

# Data & Fitted Distribution (POR GM Method)



# Data & Fitted Distribution (AGM Method)



# Initial (thru 2008) Derivation

- ◆ Both methods appropriate (AGM method believed more consistent with application of Department's TP criterion rule - therefore is preferred method) – AFWM= 16.6 (17) ppb
- ◆ Mean of methods AFWM= 17.4 (17) ppb
- ◆ Walker method 16.0 ppb (SD 0.05)

# Two Mistakes Discovered

1. Negative flow values for STAs 3/4 & 6 – corrected to zero values
2. Incorrect cell references for STA-1E values (2007 & 2008)
3. New calculated AFWMs:
  1. AGM Method – 17.2 ppb
  2. POR GM Method – 19.1 ppb
  3. Mean – 18.1 (18) ppb

# Application

- ◆ Applied at STA Discharge Structure (if multiple discharge structures @ individual STA, then flow-weighted across all discharge structures)
- ◆ Exclusions:
  - ◆ Low-flow water supply deliveries
  - ◆ Extreme events
- ◆ WQBEL periodically reevaluated as additional data become available - reevaluation of WQBEL performed @ end of each permit cycle

